Number of Students in the Imperial Tokyo University.

College, &c.	1885	1890	1895	1896	1897
University Hall...	0	47	105	146	174
Law	217	301	472	551	737
Science	43	77	102	105	105
Engineering ...	30	106	295	345	385
Medicine	726	188	178	223	297
Literature ...	129	88	219	248	278
Agriculture ...	0	485	249	215	232
Total	1145	1292	1620	1833	2208

In 1898, 30 per cent. of the total number of students were studying law, 9 per cent. medicine, 31 per cent. engineering, 7 per cent. science, and 4 per cent. agriculture.

Mr. Lewis provides interesting particulars of the subsequent careers of the graduates from Tokyo University for the year 1896. Of 308 graduates that year 107 were given administrative or judicial positions by the Japanese Government, 48 were admitted to University Hall there to engage in original research, 45 obtained posts in banking houses and similar important commercial undertakings, 44 remained unoccupied, 42 became instructors in the universities and high schools, 15 remained in the colleges for post-graduate work, and 7 took up various other callings.

As regards the annual expenditure on Tokyo University, the following table shows the amounts spent on the different constituent colleges in the year 1895:—

Imperial Tokyo University Expenditure for the Year 1895.

	£
University Hall	11,000
College of Law	9,500
College of Science	14,000
College of Engineering	15,000
College of Medicine	52,000
College of Literature	11,000
College of Agriculture	15,500
Total	128,000

Now it must be remembered that the Government department of education is responsible for the maintenance of higher education in Japan, and it is at once seen that in Japan the State found for the Tokyo University in 1895, apart from the University of Kioto, about 130,000*l*. The present State contribution to the whole of our universities and colleges together amounts only to 155,600*l*., and in favoured Germany the State endowment of the University of Berlin in 1891–2 amounted to 168,780*l*., so that with educational traditions dating back only thirty-five years Japan is well on the way to an equal State expenditure on higher education.

The students of the Tokyo University are drawn, says Mr. Lewis, from all classes of society as in America. "There seems to be no special class of men who were predestinated for the university. . . . If the past thirty years might be taken as a basis, one may look forward to the time in Japan when, as in Scotland, the universities may claim one from every thousand of the population; or when, as in Scotland, one man out of each five hundred will have a *bona fide* university degree."

Besides the institutions of higher education which have now been described, there are in Japan, according to the Japanese Government report for 1896, sixty technical schools of various kinds. Thirty-seven of these are devoted to instruction in agriculture, seven to branches of industry, and sixteen to commerce. These sixty schools employ 424 teachers, and are attended by 7600 students. Among the more important of these schools the Tokyo Technical School takes a high place. It gives instruction in electrical mechanics, electrochemistry, dyeing, weaving, and many other branches of technology. The primary object of the school is to train manufacturing experts, and the school has already gained a high reputation for the amount of its original work for the improvement of manufacturing processes. Japan also has sixteen apprentice schools with 1875 students.

Merely to state the number of technical schools in the country is to fail to give a true idea of the Japanese system of technical education, because in both the elementary and secondary schools some attention is devoted to instruction of a technical kind. Though many authorities in this country, in Germany, and in America would disapprove of this approach to early specialisation, it seems probable that the great success of institutions like the Tokyo Technical School may be due to the fact that the early introduction of Japanese boys to technical studies makes it possible to weed out those unlikely to benefit by the advanced courses of the technical schools, and to concentrate attention on those who possess natural aptitudes for such work.

Such is a brief outline of the change which has taken place in Japan since 1868, when its first provisional board of education was formed. If with all the disadvantages under which she laboured Japan has been able by persistent effort and by continuous sacrifice in the way of State endowment and private munificence to effect an educational revolution, it requires little enough faith to believe that if as a nation we set to work to put our educational house in order—to endow adequately our present universities, to establish others where they are required, to level up our secondary education—there would be no need pessimistically to contemplate the future of the Empire, and to imagine for it a possible third or fourth place in the world struggle for supremacy.

A. T. SIMMONS.

THE EVOLUTION OF MATTER AS REVEALED BY THE RADIO-ACTIVE ELEMENTS.

On Tuesday, February 23, Mr. F. Soddy delivered the Wilde lecture before the Manchester Literary and Philosophical Society. The lecture, it may be explained, is delivered annually, and is provided for out of an endowment by Dr. Henry Wilde, F.R.S.

After referring to the three-fold character of the rays emitted by radium, Mr. Soddy explained that the α-rays contained more than 99 per cent. of the whole energy given off, and were of paramount importance on other grounds, as opening up a new field of research with which the ordinary methods of chemical analysis had no connection. The mass of the particles composing the α rays was about equal to that of an atom of hydrogen; they carried a positive charge, and were deviable, though to a very minute extent, in a powerful magnetic field. Their velocity was about 20,000 miles a second, and they were easily stopped, even by a thin sheet of paper, or a few centimetres of air. All three kinds were detected by their power of exciting fluorescence in certain substances, and by their action on a photographic plate, but their distinctive property was that of ionising the air and other gases through which they pass. Had it not been that their energy effects are out of all proportion to the masses of the bodies concerned, the radio-active property would have remained undetected. Thus uranium and thorium have been known for several generations, yet it is no longer ago than 1896 that Becquerel began the researches which have since proved so fruitful in the hands of M. and Mdme. Curie, Prof. Rutherford, Sir W. Ramsay and others.

As regards the radio-active elements themselves, they are regarded as undergoing a slow spontaneous

change into other elements. The parent form disintegrates and throws off a portion of its substance, leaving a residue which undergoes a further change of a like explosive character, and so on, until a form of matter is reached in which no other change is possible. The explosion differs from that of a body like fulminate of mercury in that it does not gather strength with the mass of matter present, but is confined entirely to the individual atoms. All the effects observable in connection with radio-activity are referable to the α particles: thus fluorescence is excited in certain bodies by impact; the ionisation of a gas is brought about by the collision of these particles with the neutral molecules of the gas, whereby they are torn asunder into ions; the warmth of a mass of a radio-active substance is due to its being bombarded by its own α rays. As the process of disintegration continues, certain stages are reached in which the substances produced are of the nature of chemical elements, though differing from the ordinary conception of an element in that their existence is merely temporary. To these transition forms Prof. Rutherford and Mr. Soddy have applied the term "metabolons," and the duration of these is a specific property, depending on the nature of their aggregation. Thorium, for example, gives off an emanation which changes its character in so short a time as 87 seconds; the form of matter to which radium owes its power of exciting radio-activity in other bodies endures for about 43 minutes; that to which thorium owes a similar property lasts about 16 hours; the radium emanation for 5 days 8 hours; the uninvestigated next product of the disintegration of thorium, called thorium X, has a life of 5 days 19 hours; uranium X of about 4 weeks; polonium of 16 months; radium of 1300 years; uranium and thorium of about 10^9 years.

The atoms of ordinary chemistry represent the forms with longest life, and they exist to-day because they have survived a process of evolution in which those physically unfit have disappeared. The transition forms represent the elementary forms of matter unfitted to survive, but they are brought within our powers of knowledge because they constitute the temporary halting places through which matter is passing in a scheme of slow continuous evolution from the heavier to the lighter forms. During the whole existence of the metabolon, whether long or short, it behaves like an ordinary atom. No indication whatever seems to be given of its approaching end, but suddenly, by some internal cataclysm, the cause of which is at present almost beyond conjecture, it flies to pieces and ceases to exist in the form previously assumed. A new world is thus opened out in which the atom is not the unit, in which the forces are not chemical, and in which common physical conceptions such as temperature are without meaning.

The operation of separating the transition forms from the parent element by chemical means does not in any way affect the progress of disintegration. Left to itself, the parent element steadily accumulates a fresh crop of the transition forms separated, while the quantities originally separated disappear as such by further change. As the activity of the parent element recovers to its maximum or equilibrium value, that of the transition forms decays to zero, and the sum total is always the same as if the separation had not been effected. On this view the products of disintegration must have been steadily accumulating through past ages, and the discovery of helium by Sir W. Ramsay in 1895 was the first definite proof that such was really the case. Helium is only known in association with the radio-active elements, and its inert character is one of the reasons for supposing that it is a final product of disintegration. Sir W. Ramsay and Mr. Soddy, during last summer, examined radium with the view of discovering whether or not it resolved itself into helium, and after weeks of waiting were able to establish that this is really the case. A very minute bubble was all that could be obtained, and its slow disappearance, probably by absorption into the glass, was not unexpected. Indeed, glass which has been subjected to bombardment by the α rays, when powdered and heated, has been shown to give off helium, so that the supposition is confirmed. All kinds of glass, however, do not behave in the same manner, the absorption in some cases being much more rapid than in others.

Viewed in relation to their length of life, it seems probable that radium, actinium, and polonium are merely slow-changing transition forms produced in the disintegration of the parent element uranium. Since the activity of polonium decays to half value in about a year, it follows that its existence in pitchblende at the present time is due to its continuous production in the mineral. Applying the same argument to radium, it must also be in a state of equilibrium, the amount produced in any given time being balanced by its rate of decay to inferior forms in that time. The lecturer had endeavoured to discover whether a quantity of uranium, originally free from radium, would grow a crop of that element, but a lengthy period must elapse before a definite conclusion can be reached. There is also an unknown factor in these considerations, viz. actinium, and until this element has been further investigated even speculation must be withheld. Pushing the matter back to its limits, we are face to face with the question, How and when did the universe originate? According to orthodox notions, it is tending to a state of exhaustion in which all change must cease. If, however, a constructive influence is at work, opposing this process, the whole system may turn out to be a conservative one, limited with respect neither to the future nor to the past, but proceeding through continuous cycles of evolution. This would be possible if a gradual and continuous accretion of atomic mass could take place, such as that by which the stable elements were originally formed. At present, however, all such views belong to the realm of pure conjecture.

LIEUT.-GENERAL C. A. McMAHON, F.R.S.

CHARLES ALEXANDER McMAHON, son of Captain Alexander McMahon, of the East India Co.'s Service, belonged to an old Irish family, and was born near Highgate on March 23, 1830. Educated as a soldier, he went to India in 1847 as Lieutenant in the Madras Native Infantry, and served for eight years in the 39th Regiment. In 1856 he was appointed a Commissioner in the Punjab, and was engaged for thirty years in various districts, including Lahore.

While politics and educational questions occupied much of his time, he became greatly interested in geology, and especially in the crystalline rocks and glacial phenomena of the western Himalayas. In his earlier work he was impressed with the intrusive character of the central gneiss of the great mountain range, and his enthusiasm was so aroused that he took the opportunity, while on furlough in 1879–80, of attending the courses at the Royal School of Mines, so as to be initiated in the latest methods of petrological research. Returning to India he worked with renewed zeal at the igneous and metamorphic rocks, and the results of his observations were mostly published in the records of the Geological Survey of India.

In 1885 he retired from service with the rank of colonel, and settled in London. He had been elected a fellow of the Geological Society in 1878, and he now took an active part in the work of the society, serving